



Illinois Department of Transportation

Memorandum

To: ALL BRIDGE DESIGNERS 03.1
From: Ralph E. Anderson *Ralph E. Anderson*
Subject: TEMPORARY SHEET PILING DESIGN AND PLAN DETAILS
Date: January 6, 2003

This Bridge Memorandum supersedes the previously issued Bridge Memorandum 97.5.

Various contracting and construction issues have lead to changes in the Special Provisions and the addition of a new item for supporting the faces of excavations during construction. The traditional item, Temporary Sheet Piling, will be used when conditions permit the use of a cantilever design. A new item called Temporary Soil Retention System, will be used when a cantilever design is not feasible. These changes require more comprehensive guidance on plan details and notes used for both situations depending on what site conditions will permit. The attached temporary sheet piling design charts remain unchanged from those previously issued. These charts have been successfully used to reduce construction submittals and simplify plan preparation for several years.

During the TSL phase, the planner should consider the feasibility and expense of any temporary retention required to construct a particular structure to ensure the most appropriate structure type, size and location is selected. A cantilevered sheet piling design is preferable and is normally less expensive, but when the retained height or subsurface conditions appear to prevent a cantilevered design, the planner will need to consider a more complicated system utilizing deadmen, wales, braces, soldier piles etc. In either case, the TSL plan view should only show sheet piling as it is considered a generic symbol to denote temporary retention will be required.

In the final plan preparation, the actual retention limits (exposed surface area) required to construct the proposed structure shall be calculated. This is defined by the retained ground surface in stage I and stage II, the cut slopes required for construction and the removal of existing structures.

The minimum tip elevations and section modulus shall be provided on the plans, along with the retention limits on which they were based, when the temporary sheet piling cantilever design charts are utilized. In these cases, the Special Provision for Temporary Sheet Piling (Guide Bridge Special Provision 32) shall be used.

When a cantilevered design is not feasible, the new Guide Bridge Special Provision (GBSP 44) and pay item "Temporary Soil Retention System" shall be used. The retention limits shall be shown on the plans to provide the contractor the information

required to accurately bid and design the retention system. Since the pay item quantity for this item is the exposed surface area envelope, care should be taken to accurately determine these dimensions and show them on the plans.

Attached are examples of how the elevation view detail in either case should be shown. The following issues shall be considered in developing this detail:

- 1) **The detail shall show the sheeting or retention system extending to the retained ground surface.** Some past projects have shown and paid for sheeting extending 1' or 1 meter above ground surface. This has created confusion regarding the pay quantity and the retained height to use in the design, particularly when it is only labeled "top of sheeting". The new detail shall extend to the retained ground surface and be labeled ground surface/top of sheet piling (or soil retention system). If the stage II ground surface is significantly higher than stage I, the stage II portion shall be shown extending to the higher elevation.
- 2) **The maximum excavation line against the face of the sheeting or retention system shall be shown, labeled and defined with slopes, elevations and distances.** This information documents the excavation depths for which the design minimum tip elevations and section modulus shown on the contract plans would be adequate. When the Contractor provides the design, these limits will be needed to properly bid and ensure correct retention heights are used in their retention system design. Common mistakes are using the top of the rip rap line as the maximum excavation (instead of the bottom), and not accounting for the excavation necessary to remove existing structures or unsuitable soils.
- 3) **The minimum tip elevation of the sheet piling shall be shown as a line parallel to the maximum excavation line.** To minimize cost, the sheeting shall now be shown at a constant embedment depth as opposed to the previous practice of a constant tip elevation. Where major changes in the retained height occur, the designer may show a different section modulus and embedment, such changes would result in a stepped minimum tip elevation line.
- 4) **The plan view length of the sheeting or retention system shall be determined by the intersection between the maximum excavation line and the ground surface.** A common mistake is forgetting to account for the skew. For example, for a structure on a 40 degree skew, a cut slope of 1:1 at right angles to the abutment would result in a 1.31:1 slope along the centerline of the roadway. On the other extreme, there is no need to be overly conservative and show excessive lengths either.
- 5) **Existing footings, which may interfere with sheeting penetration, shall have their "top of footing elevation" and "footing heel width" shown in the detail.** This enables the Contractor to utilize appropriate sheet lengths, correctly size abutment connections, or account for its presence if required to provide a design. The footing heel width should be shown along the skew of the sheeting when the sheeting is not at right angles to the stem.

- 6) **If existing structure removal adjacent to the sheeting or retention system is required, the limits shall be shown and the maximum excavation line should be consistent with that removal.** The removal limits specified in 501.02 of the standard specification are a minimum. The designer should anticipate the likely extent of structure removal and associated excavation and provide an appropriate design with the assumptions shown. If the Contractor intends to remove more than indicated or excavate beyond the limits shown, they will have to submit for approval all appropriate adjustments to the design in advance.
- 7) **Any other design constraints (buried utilities, overhead power lines, top of rock etc.) shall be noted on the sheeting or retention system detail.** Failing to alert the Contractor of these known constraints can delay or complicate construction. These constraints are best dealt with by providing advanced notice on the contract plans so the Contractor can account for these factors in their bid.
- 8) **Do not show wales, soldier piles, sheeting, deadmen, or other potential retention system components if the cantilever sheet piling design charts are not applicable for the conditions of the project.** Showing specific elements may lead Contractors to bid assuming these may be required. The plan view should use the standard zigzag sheet piling symbol (labeled as Temporary Soil Retention System) and the elevation detail should only show the retention limits.

Along with the plan details discussed above, the following note(s) shall be included when applicable:

When a cantilevered design is placed on the plans:

"If the Contractor chooses to alter the temporary cantilevered sheet piling design requirements shown on the plans, a design submittal including plan details and calculations will be required for review and acceptance by the Engineer."

When a footing interferes with required sheeting penetration:

"The Contractor shall connect the first sheet to the existing abutment wall to ensure stability of sheets driven to the top of the existing footing. This connection shall be reviewed and accepted by the Engineer and included in the cost for Temporary Sheet Piling."

When a stiff or dense soil layer is present which might be penetrated with a larger hammer:

"Hard driving may be encountered during the sheet piling installation. The Contractor shall provide the appropriate driving equipment for the soil conditions indicated on the boring logs."

When a temporary sheet piling design cannot be provided on the plans:

"A cantilevered sheet piling design does not appear feasible and additional members or other retention systems may be necessary. The Contractor shall submit a temporary soil retention system design including plan details and calculations for review and acceptance by the Engineer."

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Adherence to this policy is intended to simplify the plan preparation, maintain plan consistency, further reduce plan corrections, and minimize construction problems related to this work.

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TEMPORARY SHEET PILING DESIGN CHART USE, APPLICATION LIMITATIONS, AND DEVELOPMENT ASSUMPTIONS

DESIGN CHART USE:

First determine the Retained Height at a particular design section of the sheeting and assume an embedment depth.

- 1) If cohesive soil conditions are indicated in the nearest boring log within the assumed embedment depth elevations, use the charts for the cohesive material case as follows:
 - a) Calculate the average Unconfined Compressive Strength (Q_u), used in the Required Embedment chart, as the minimum of the following:
 - (i) The average of the Q_u values, within the assumed embedment depth.
 - (ii) The average of the Q_u values in the upper 50% of the assumed embedment depth.
 - b) Find the Required Embedment using the average Unconfined Compressive Strength determined above and the retained height. If the required embedment depth obtained from the chart is different than assumed, re-calculate the average Unconfined Compressive Strength using an adjusted embedment depth until the assumed embedment depth used in calculating the average Unconfined Compressive Strength equals the resulting embedment depth from the chart.
 - c) Calculate the average Unconfined Compressive Strength (Q_u) used in the Required Section Modulus chart as the average of the Q_u values in the upper 33% of the required embedment determined above.
 - d) Find the Required Section Modulus directly using this average Unconfined Compressive Strength (Q_u) and the retained height.
- 2) If granular soil conditions are indicated in the nearest boring log within the assumed embedment depth elevations, use the charts for granular material case as follows:
 - a) Calculate the average Standard Penetration Blow Count (N-value), used in the Required Embedment chart, as the minimum of the following:
 - (i) The average of the N values, within the assumed embedment depth.
 - (ii) The average of the N values in the upper 50% of the assumed embedment depth.
 - b) Find the Required Embedment using the average Standard Penetration Blow Count determined above and the retained height. If the required embedment depth obtained from the chart is different than assumed, re-calculate the average Standard Penetration Blow Count using an adjusted embedment depth until the assumed embedment depth used in calculating the average Standard Penetration Blow Count equals the resulting embedment depth from the chart.
 - c) Calculate the average Standard Penetration Blow Count (N-value) used in the Required Section Modulus chart as the average of the N-values in the upper 33% of the required embedment determined above.
 - d) Find the Required Section Modulus directly using this average Standard Penetration Blow Count (N-value) and the retained height.
- 3) If both cohesive and granular soil layers are indicated in the nearest boring log within the assumed embedment depth elevations,
 - a) Multiply the Q_u values (in tsf.) of each cohesive sample by 10 to determine an equivalent granular N-value.
 - b) Using the equivalent granular N-values in the cohesive layers together with the N-values in the granular layers, treat the soils as granular and follow the steps in part 2).

APPLICATION LIMITATIONS:

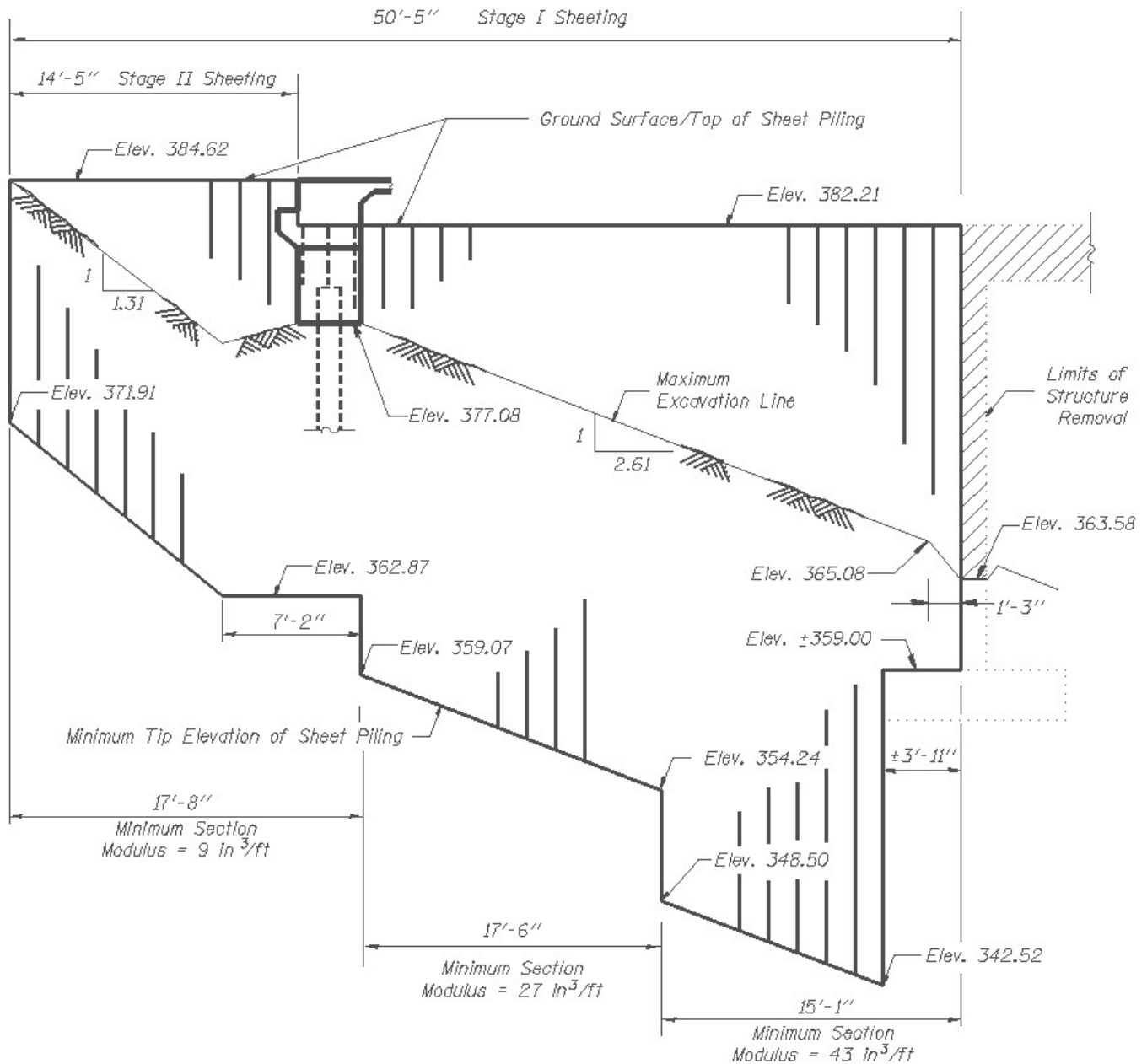
- 1) The Design Charts are only applicable for temporary soil retention.
- 2) If the required embedment falls below soil layers with a Q_u value larger than 4.5 tsf., an N-value larger than 45 blows, or rock, the charts can not be used for the design since the sheet piling may not penetrate these layers.
- 3) If the average Q_u value in the lower half of the upper 1/3 of the embedment is more than twice as large as the average Q_u value in the upper half of the upper 1/3 of the embedment, the section modulus in the chart must be increased by the following factors:

<u>Average Q_u in lower half of upper 1/3 embedment</u> <u>Average Q_u in upper half of upper 1/3 embedment</u>	2	3	4	5	6
Section Modulus Amplification Factor	1.0	1.1	1.2	1.3	1.4

- 4) The Design Charts can only be used at locations where at least one Boring is available, located within a reasonably close distance to the sheet piling. In addition to distance, the user must consider the general topography and site conditions to confirm that the soil conditions indicated in the boring log are likely to be present at the sheeting location.
- 5) When following the design chart use procedures results in an embedment or section modulus falling on a blank location on the chart, a design by the charts will not possible.
- 6) A level ground surface must exist behind and front of the sheet piling.
- 7) If any of the site conditions do not meet or are not consistent with the "Design Chart Assumptions", the design charts are no longer applicable and should not be used.

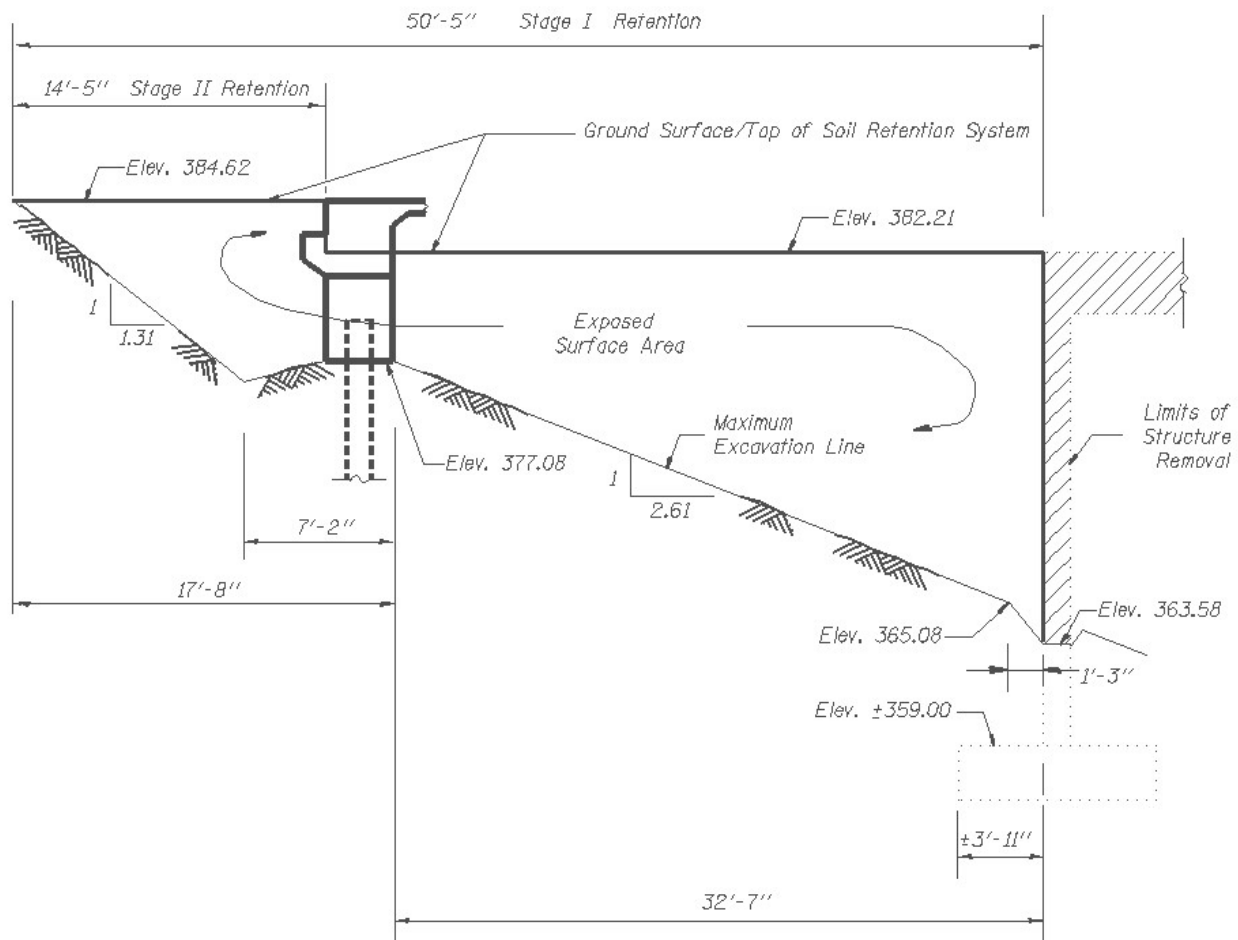
DEVELOPMENT ASSUMPTIONS:

- 1) The soil unit weight used through the retained height is 120 pcf.
- 2) The soil unit weights used below the excavation depth were determined using general S.P.T. N-value vs. unit weight correlations. In the Cohesive Material Case, the average Q_u was multiplied by 10 to obtain an equivalent S.P.T. N-value and the correlation between S.P.T. N-value and unit weight was used.
- 3) A uniform vertical surcharge of 240 psf. has been used to account for the traffic live load.
- 4) In addition to the traffic surcharge load (which results in a uniform lateral distributed pressure of 80 psf.), an equivalent fluid pressure of 40 pcf. has been used throughout the retained height.
- 5) Coulomb's earth pressure theory has been used in the development of the Granular material case, assuming a wall friction angle of $1/3 \phi$. The friction angles used were determined using general relationships between the S.P.T. N-value vs. friction angle.
- 6) A minimum active earth pressure coefficient of 0.25 has been used below the retained height.
- 7) For the Cohesive material case, the assumption is made that the shear strength (c), is equal to one-half of the average unconfined compressive strength, (Q_u).
- 8) The factor of safety for embedment was obtained by reducing the calculated passive pressure diagram by 33%, which resulted in an increase in embedment ranging from 26% to 35% for the granular case and 43% to 80% for the cohesive case. To avoid over-reliance on the strength of only a few samples, the minimum embedment used in the charts was limited to no less than 75% percent of the retained height.
- 9) The required section modulus has been computed using 33% reduction on passive soil pressures and the relationship $f_b = .66 \times f_y$, where the sheet piling yield stress (f_y) is 38,500 psi.



Temporary Sheet Piling Design Example

Slopes and Distances Shown Along Alignment of Sheet piling (for structure with 40 degree Skew)



Temporary Soil Retention System Example

Slopes and Distances Shown Along Alignment of Sheet piling (for structure with 40 degree Skew)

TEMPORARY SHEET PILING DESIGN CHART-COHESIVE MATERIAL CASE

RETAINED HEIGHT (FT.)																			
5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			

REQUIRED EMBEDMENT DEPTH (FT.)

0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

AVERAGE
UNCONFINED
COMPRESSIVE
STRENGTH -
"Qu" (T.S.F.)

6.5	10.0																		
5.1	6.8	9.0	13.1																
4.3	5.7	7.2	9.1	11.6	16.1														
3.8	4.9	6.2	7.7	9.4	11.4	14.2	19.1												
3.8	4.5	5.5	6.8	8.3	9.9	11.6	13.9	16.7	22.1										
3.8	4.5	5.3	6.1	7.4	8.8	10.3	12.0	13.9	16.3	19.5	25.2								
3.8	4.5	5.3	6.0	6.8	8.0	9.3	10.8	12.4	14.2	16.3	18.8	22.3	28.2						
3.8	4.5	5.3	6.0	6.8	7.5	8.5	9.9	11.3	12.9	14.5	16.4	18.7	21.3	25.2	31.3				
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.1	10.4	11.8	13.4	15.0	16.7	18.7	21.1	23.7	28.1			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	11.0	12.4	13.8	15.4	17.1	18.9	21.1	23.5			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.5	12.9	14.4	15.9	17.5	19.2	21.2			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.1	13.5	14.9	16.4	17.9	19.6			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	14.0	15.4	16.9	18.4			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.6	15.9	17.4			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.1	16.5			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.0	15.8			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.0	15.8			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.0	15.8			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.0	15.8			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.0	15.8			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.0	15.8			
3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.0	15.8			

REQUIRED SECTION MODULUS (IN ³/FT.)

0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

AVERAGE
UNCONFINED
COMPRESSIVE
STRENGTH -
"Qu" (T.S.F.)
IN UPPER 1/3
OF REQUIRED
EMBEDMENT

1.4	2.4	4.7																	
1.3	2.1	3.3	5.1	8.3															
1.2	2.0	3.0	4.5	6.4	9.0	13.5													
1.1	1.8	2.8	4.1	5.9	8.1	10.9	14.8	20.5											
1.1	1.8	2.7	3.9	5.5	7.5	10.1	13.2	17.0	22.3	29.6	42.8								
1.1	1.7	2.6	3.8	5.3	7.2	9.5	12.4	15.9	20.1	25.2	31.9	41.1	55.2						
1.0	1.7	2.5	3.7	5.1	6.9	9.1	11.8	15.1	19.0	23.6	29.0	35.1	44.5	55.4					
1.0	1.6	2.5	3.6	4.9	6.7	8.8	11.4	14.5	18.2	22.5	27.6	33.5	40.3	49.0	59.3				
1.0	1.6	2.4	3.5	4.8	6.5	8.6	11.0	14.0	17.5	21.6	26.4	32.0	38.4	45.7	54.1				
1.0	1.6	2.4	3.4	4.7	6.4	8.4	10.8	13.6	17.0	21.0	25.5	30.8	36.9	43.9	51.7	60.6			
1.0	1.6	2.4	3.4	4.7	6.3	8.2	10.5	13.3	16.6	20.4	24.8	29.9	35.7	42.3	49.8	58.3			
1.0	1.6	2.3	3.3	4.6	6.2	8.1	10.3	13.0	16.2	19.9	24.2	29.1	34.7	41.1	48.3	56.4			
1.0	1.5	2.3	3.3	4.5	6.1	7.9	10.2	12.8	15.9	19.5	23.7	28.4	33.9	40.0	47.0	54.8			
1.0	1.5	2.3	3.3	4.5	6.0	7.8	10.0	12.6	15.7	19.2	23.2	27.9	33.2	39.1	45.9	53.4			
1.0	1.5	2.3	3.2	4.4	5.9	7.7	9.9	12.5	15.4	18.9	22.8	27.4	32.5	38.4	44.9	52.2			
0.9	1.5	2.3	3.2	4.4	5.9	7.7	9.8	12.3	15.2	18.6	22.5	27.0	32.0	37.7	44.1	51.2			
0.9	1.5	2.2	3.2	4.4	5.8	7.6	9.7	12.2	15.1	18.4	22.2	26.6	31.5	37.1	43.4	50.3			
0.9	1.5	2.2	3.2	4.3	5.8	7.5	9.6	12.1	14.9	18.2	22.0	26.3	31.1	36.6	42.7	49.6			
0.9	1.5	2.2	3.2	4.3	5.8	7.5	9.5	12.0	14.8	18.0	21.7	26.0	30.7	36.1	42.2	48.9			
0.9	1.5	2.2	3.1	4.3	5.7	7.4	9.5	11.9	14.6	17.9	21.5	25.7	30.4	35.7	41.6	48.3			
0.9	1.5	2.2	3.1	4.3	5.7	7.4	9.4	11.8	14.5	17.7	21.3	25.5	30.1	35.3	41.2	47.7			
0.9	1.5	2.2	3.1	4.3	5.7	7.3	9.4	11.7	14.4	17.6	21.2	25.2	29.8	35.0	40.8	47.2			

TEMPORARY SHEET PILING DESIGN CHART-GRANULAR MATERIAL CASE

RETAINED HEIGHT (FT.)														
5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

REQUIRED EMBEDMENT DEPTH (FT.)

AVERAGE STANDARD PENETRATION RESISTANCE - "N-VALUE" (BLOW COUNT PER FT.)	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
12.1	13.9	15.7	17.5	19.3	21.0	22.9	24.6	26.4	28.2	30.0	31.7					
11.3	13.0	14.6	16.3	18.0	19.7	21.4	23.0	24.7	26.3	28.0	29.7	31.3				
10.7	12.3	13.8	15.4	17.0	18.6	20.2	21.8	23.4	24.9	26.5	28.1	29.6				
10.2	11.7	13.2	14.7	16.2	17.7	19.3	20.8	22.3	23.8	25.3	26.8	28.3				
9.7	11.2	12.7	14.1	15.6	17.0	18.5	19.9	21.4	22.8	24.3	25.7	27.1				
9.4	10.8	12.2	13.6	15.0	16.4	17.8	19.2	20.6	22.0	23.4	24.8	26.2				
9.1	10.4	11.8	13.2	14.5	15.9	17.3	18.6	20.0	21.3	22.6	24.0	25.3	26.7			
8.8	10.1	11.5	12.8	14.1	15.4	16.8	18.1	19.4	20.7	22.0	23.3	24.6	25.9			
8.6	9.9	11.2	12.4	13.7	15.0	16.3	17.6	18.8	20.1	21.4	22.7	23.9	25.2			
8.3	9.6	10.9	12.1	13.4	14.6	15.9	17.1	18.4	19.6	20.9	22.1	23.3	24.6			
8.1	9.4	10.6	11.8	13.1	14.3	15.5	16.7	18.0	19.2	20.4	21.6	22.8	24.0			
8.0	9.2	10.4	11.6	12.8	14.0	15.2	16.4	17.6	18.8	19.9	21.1	22.3	23.5			
7.8	9.0	10.2	11.3	12.5	13.7	14.9	16.0	17.2	18.4	19.5	20.7	21.9	23.0			
7.7	8.8	10.0	11.1	12.3	13.4	14.6	15.7	16.9	18.0	19.2	20.3	21.4	22.6	23.7		
7.5	8.7	9.8	10.9	12.1	13.2	14.3	15.5	16.6	17.7	18.8	19.9	21.1	22.2	23.3		
7.4	8.5	9.6	10.7	11.8	13.0	14.1	15.2	16.3	17.4	18.5	19.6	20.7	21.8	22.9		
7.3	8.4	9.5	10.6	11.7	12.7	13.9	14.9	16.0	17.1	18.2	19.3	20.4	21.5	22.5		
7.1	8.2	9.3	10.4	11.5	12.5	13.6	14.7	15.8	16.8	17.9	19.0	20.0	21.1	22.2		
7.0	8.1	9.2	10.3	11.3	12.4	13.5	14.5	15.6	16.6	17.7	18.7	19.8	20.8	21.9		
7.0	8.0	9.1	10.1	11.2	12.2	13.3	14.3	15.4	16.4	17.4	18.5	19.5	20.6	21.6		
6.9	7.9	9.0	10.0	11.0	12.1	13.1	14.2	15.2	16.2	17.2	18.3	19.3	20.3	21.4		
6.8	7.8	8.9	9.9	10.9	11.9	13.0	14.0	15.0	16.0	17.1	18.1	19.1	20.1	21.1		

REQUIRED SECTION MODULUS (IN⁴/FT.)

AVERAGE STANDARD PENETRATION RESISTANCE - "N-VALUE" (BLOW COUNT PER FT.) IN UPPER 1/3 OF REQUIRED EMBEDMENT	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
4.0	6.1	8.9	12.4	16.7	21.8	27.9	35.0	43.2	52.5							
3.7	5.6	8.2	11.4	15.3	20.0	25.6	32.1	39.7	48.3	58.1						
3.4	5.3	7.6	10.6	14.3	18.7	23.9	30.0	37.1	45.2	54.3						
3.2	5.0	7.2	10.1	13.5	17.7	22.6	28.4	35.1	42.8	51.4						
3.1	4.7	6.9	9.6	12.9	16.9	21.6	27.1	33.5	40.8	49.1	58.4					
2.9	4.5	6.6	9.2	12.4	16.2	20.8	26.1	32.2	39.2	47.2	56.1					
2.8	4.4	6.4	8.9	11.9	15.6	20.0	25.2	31.1	37.8	45.5	54.2					
2.7	4.2	6.2	8.6	11.6	15.2	19.4	24.4	30.1	36.7	44.1	52.5					
2.7	4.1	6.0	8.4	11.2	14.7	18.9	23.7	29.3	35.7	42.9	51.1	60.2				
2.6	4.0	5.8	8.1	11.0	14.4	18.4	23.1	28.5	34.8	41.8	49.8	58.7				
2.5	3.9	5.7	7.9	10.7	14.0	18.0	22.6	27.9	34.0	40.9	48.6	57.3				
2.5	3.8	5.6	7.8	10.5	13.7	17.6	22.1	27.3	33.2	40.0	47.6	56.1				
2.4	3.7	5.5	7.6	10.3	13.5	17.2	21.6	26.8	32.6	39.2	46.7	55.0				
2.4	3.7	5.4	7.5	10.1	13.2	16.9	21.3	26.3	32.0	38.5	45.8	54.0				
2.3	3.6	5.3	7.3	9.9	13.0	16.6	20.9	25.8	31.5	37.9	45.1	53.1				
2.3	3.6	5.2	7.2	9.7	12.8	16.4	20.6	25.4	31.0	37.3	44.3	52.3				
2.3	3.5	5.1	7.1	9.6	12.6	16.1	20.2	25.0	30.5	36.7	43.7	51.5	60.2			
2.2	3.4	5.0	7.0	9.5	12.4	15.9	20.0	24.7	30.1	36.2	43.1	50.8	59.3			
2.2	3.4	5.0	6.9	9.3	12.3	15.7	19.7	24.4	29.7	35.8	42.6	50.2	58.7			
2.2	3.4	4.9	6.9	9.3	12.1	15.6	19.5	24.2	29.4	35.4	42.2	49.7	58.1			
2.2	3.3	4.9	6.8	9.2	12.0	15.4	19.4	23.9	29.2	35.1	41.8	49.3	57.6			
2.1	3.3	4.8	6.7	9.1	11.9	15.3	19.2	23.7	28.9	34.8	41.4	48.8	57.1			